Real-time Tracking and Tracing System: Potentials for the Logistics Network

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Abstract

The importance of tracking and tracing of shipments is considered quite high for manufacturing firms in terms of customer service and essential for managing logistics networks efficiently. Global industries are facing problems both from tracking and tracing in their logistics networks that creates huge coordination problems in the overall product development sites. This paper presents a sophisticated overview on technology-based methodology or approach for solving the complex tracking and tracing system in the logistics and supply chain network. The main objective of this research is to the management of logistics network through analyzing the new technological opportunities on real-time shipment tracking in dispersed manufacturing environment. It is hoped that these technologies would be able to offer solutions for tracking and tracing distribution chains through future information technologies such as available real time tracking technologies.

Keywords
Logistics tracking, IT-based solution, Distribution network, Real-time information flow, Business competition.

1. Introduction

The importance of tracking and tracing of shipments is considered quite high for manufacturing firms in terms of customer service and essential for managing logistics networks efficiently. Global industries are facing problems both from tracking and tracing in their logistics supply networks, that creates huge coordination problems in the overall product development sites. This problem loose the track among production, delivery and distribution in the complete logistics chain from source to destination, which is responsible for opportunity cost through customers’ dissatisfaction. Tracking system helps to identify the position of the shipment and informed the customer in well advance. Without tracking system it is almost impossible to find out delivered items and often considered as lost or stolen item that causes business loss. This system might fulfill the needs of project manager to map the production process from transportation to material management [1, 2].

In practice, there are several tracking systems available through GPS, GTIN [3], RFID [4], Barcode etc; however, all these systems are not fully compatible for industry. Most of the available tracking and tracing systems utilize proprietary tracking numbers defined by the individual companies operating systems and are based on information architecture, where the tracking information is centralized to the provider of the tracking service. Existing tracking systems can not able to identify the contents within a box for example, whether the box is open or the contents are lost or stolen etc. In order to tackle such misalignments in the logistics channel a state-of-the art technologies or tools are needed to be developed for sustainable production process. These tools are needed to be cost effective and at the same time possibility for reuse or recycling for any circumstances. Before proceed towards the real-time tracking technology, it is crucial to analyze its possible cause and effects. Optimal performance measures for the technologies could ensure projects success for any industries.

Tracking technologies in logistics networks are implemented fairly little in the global technology industry. Mostly high volume of global industries are implemented this technology with limited capabilities. The basic methods for all these tracking systems are usually confined for the customer to access the tracking information are within the area of tracing the shipments through manual queries such as using a www-site or telephone call, e-mailing, fax or to engage in developing systems interfaces or integrating with the tracking system. There is even no available tracking system between invoice and transportation. Customers got their ordered goods through calling or e-mailing the
Shamsuzzoha and Helo

vendors and there do not existing real-time tracking and tracing technologies. This lacking affect to network and relationship structures between manufacturers and potential customers. Thus industries need a concept, methods, tools and competencies to systematically develop their real-time tracking technologies for logistics network.

Without proper and suitable tracking and tracing system, efficient co-ordination of logistic flow would be difficult to acquire [5]. Through the implementation of this system, it is possible to detect and reacting any uneven situations in the logistics chain and where needed significant problems can be resolved or at least the damage can be minimized [6, 7]. This system is also considered as a key service requirement for the global transportation industries especially, when they are integrated with the manufacturing companies adopting just-in-time operational strategy [8]. In case of tracking and tracing technology several issues are considered to be applicable in an inter-organizational communication such as operational scope, goods identification technology, coding of the tracked items, information architecture, accessing the tracking information etc [9, 10].

2. Literature Review

The tracking and tracing of logistics networks is recently considering a very important issue in the global supply chain management (SCM). It is identified as the search for competitive advantage, where manufacturing firms have recognized the potential importance of their logistics networks. There is no universally accepted definition of tracking and tracing in the logistics literature. In most occasion tracking is usually been attached with tracing commonly termed as ‘tracking and tracing’ [9, 11]. The term tracking can be identified as the collecting and managing the information of the present location of a product(s) or delivery item(s). On the other hand, tracing system signifies to storing and retaining the life cycle history of the manufacturing and distribution of product(s) and its components [9, 12, 13, 14, 15].

This tracking and tracing system is considered as industrial norms to provide customer services which consequently trigger competitive advantage for the logistics service providers (LSPs) too. The demand for logistics network tracking and tracing of items has been long since recognized by the individual industries. The academic communities along with standardization organizations are also actively looking forward in efforts to develop global identification methods for items or products [15]. The standard procedures developed so far are mainly concern with identification of items and as such, do not directly define any connection to product tracking systems. The complexity of the logistics chains in global industry has meant an increasing interest in improving their manageability [16]. Due to the diversity of product variants together with the necessity to improve on product traceability, a lot of information about the items is needed [13, 17].

This tracking tracing system is considered an extremely useful service in the industrial logistics management and for satisfying higher customers’ demands [18, 19, 20]. Organizational managers noticed this tracking system as a means of strengthening their market position through improved customers’ satisfaction and implementation of information technology (IT) [21]. This system covers globally both physical and information logistics networks more transparency with effectively and efficiently in today’s changing market environments. However, most of the existing tracking of shipments is designed for the purpose of a single organization and therefore there is lacking of tracking and tracing for multi-organization environments [22].

Most of the single logistics company focus on the reduced span of tracking and tracing, which offers easier accessibility of information and maintain the proprietary tracking codes and information architectures. Independent providers of tracking service such as Savi Technologies and EURO-LOG offer the development underline the importance of customers being able to locate shipments in-transit through planning and monitoring their operations [21, 23, 24]. The existing tracking systems are suitable for use when goods are handled by one company and are not suitable for multi-company networks [13, 15]. These company specific tracking services utilize service provider-specific coding for consignments, which resulted increase the complexity of retrieving tracking information for the potential customers.

3. Research Scope and Content

3.1 Research Objectives and Methodology

Ever increasing trends on product customization and reduced delivery time forces companies of looking for state-of-the-art technologies or methodologies to develop optimal tracking systems with real-time information processing. This optimal tracking system should satisfy both the manufacturers and their suppliers within the projected logistics
supply networks. This research study ensures an interactive forum for companies’ supply-demand network to learn and share the concepts and benefits concerning logistics network tracking technologies. This projected work is also developed with a view to study, what kind of practices industries do in terms of logistics tracking and what kind of practices or technologies would fit in particular business scenarios. The specific target of this research is therefore can be summarized as follows.

- Description of information flows within the logistics chains
- Definition of the specifications for the tracking system
- Description of the tracking technologies
- Analysis of tracking logistics in supplier networks
- Analysis of the potential partners in delivering the IT-solution.

3.2 Research Targets and Research Questions

The purpose of this research project is to create knowledge concerning learning in networks, and help companies to develop tracking system within logistics supplier networks. Our goal is to create a framework, models, methods and tools to facilitate the state-of-the-art tracking and tracing technology in supply chain logistics networks. These targets require finding answers to the following three research questions:

1. How do customer companies define logistics networks and what kinds of needs are there for tracking the logistics network development?
2. How do companies track and trace their logistics networks in an international context?
3. What kind of concepts, methods and tools do support in collaborative logistics networks in different industrial environments?

4. Definition and Specification of Logistics Tracking and Tracing Networks

The real-time track and trace system is essential to manage the integrated logistics networks and to enhance customer services. In literature various authors defined real-time tracking and tracing in different ways. According to APICS Dictionary [25] traceability has two fold; (1) the attribute that allows the ongoing location of a shipment to be determined and (2) the registering and tracking of parts, processes and materials used in production, by lot or serial number. Traceability is defined by the ISO [26] as the ability to track the origin of materials and parts, the product processing history and the distribution and location of the product after delivery. There exists distinction between product tracking and product tracing. Product tracking initiates from the concept of product value or associated risk, whereby individual wishes to locate the products. On the other hand, product tracing initiates from exception handling, whereby individual wishes to establish the source of (bad) quality [12]. Tracking and tracing can be subdivided into forward and backward part respectively, where tracking part consists of determining the location of the items during their way through the logistics chain and the tracing part consists of determining the source of the problem of a defective item in the logistics network [27]. Weigand [28] is defined tracking and tracing a modern tool that offers insight into the origin of products which is used to optimize and to enhance the total supply chain network.

The tracking and tracing system is not merely restricted to the manufacturers’ level only but also to the entire supply chain networks, which are separated by market forces. In respect to tracking and tracing system, supply chain networks can be considered as the integrative approach for dealing with planning and control of materials from suppliers to end-users [9]. Proper tracking and tracing is therefore required all necessary information of the supply networks in order to be managed efficiently and effectively. Various parties within supply chain logistics network need to work together in order to determining the requirements for tracking and tracing. With respect to tracking and tracing system, Jansen [12] divides the supply chain logistics parties into two groups: suppliers and industrial customers and end-customers. In terms of tracking and tracing, suppliers and industrial customers impose requirements on the supply chain as ‘business-to-business’ requirements whereas; end-customers impose requirements on the supply chain as ‘business-to-consumer’ requirements.

5. Description of the Tracking and Tracing Technologies

The tracking system is usually considered as the link between the information systems and the physical reality (the material flow) in the logistics network [11]. This system is seen as a key service component for the transportation industry to fulfill the needs of manufacturing companies. In logistics chain, the delivery notification at real-time is very important and the immediate status of delays or other delivery problems are required to notify as soon as
possible. By tracking and tracing the materials flow, it is possible to detect and to react in any uneven or unexpected events before they cause significant problems or at the very least, the damage can be reduced [7, 11].

The generic technology behind the tracking and tracing system is that when a track item arrives at a predefined place in the logistics network, the arrival is notified and a message regarding the arrival is sent to a tracking database [7, 21, 29]. The arrival message contains three basic information regarding the materials or shipments such as the identity of the predefined point, the location of the point and the arrival time to the predefined point [11]. There might other related information regarding the shipments too such as quality and quantity of the shipped items, previous and next delivery point, etc. Different available tracking technologies can be discussed in the following paragraphs.

5.1 Codifying the Shipped Item

Before implementing the tracking and tracing system for any shipped item it is required to codify based on the specific functionalities of the logistics network. The function of codifying an item or product is to facilitate the easy information exchange between the potential partners of the logistics chain. Before coding a deliverable item care should be taken in order to develop the error free tracking and tracing network and the provision for safeguard extensions for future applications. Product codification has several functionalities such as; tracking and management of transportation, efficient storage and retrieval of items, sorting of products or items, tracking of work in process in case of manufacturing processes etc. Shipped items with proper coding enable automated and inexpensive information exchange between logistics partners and provide a more current and flexible view of business networks.

The available technologies for tracking and tracing include: barcode, radio frequency identification (RFID), magnetic stripe, voice and vision systems, optical character recognition and biometrics. The predominant choice of identification technology is bar coding, where the system utilize mostly proprietary tracking numbers defined by the company operating system and are based on information architecture [7]. The tracking information is centralized to the provider of the tracking service from where customer to access the tracking information through interfacing or integrating with the tracking system. Figure 1 displays the basic architecture of the tracking network, where the coded item travelled from base station to the end-customer via different distribution points. The information from each of the distribution points is updated for necessary tracking and tracing.

5.2 Tracking and Tracing of the Shipped Item

The technology behind the tracking and tracing of a coded shipped item is started from an infrared code reader as displayed in Figure 2. This code reader stored the full history of the tracked item such as item name, shipment starting date, item price etc. After storing the initial information of the item, it is travelled to various locations on its way to the end point. Each of the travelled location there is a server to identify the item location. A centralized server keeps the necessary tracking information all the way of the item to the potential customer. This server is connected to each of the intermediate servers on the way of coded item. The shipped item is also monitored all the way and the required information is stored in the central tracking database from where the information is retrieved according to necessary.
The server at each of the location contains the information of the item regarding item name, location ID, current time, item quality and quantity etc. In quality checking, the item is scanned for its status such as damaged or partial damaged or not especially in case of perishable item, broken fully or partially or not in case of non-perishable item etc. The quantity checking also ensures the missing or stolen item from the shipped cartons or lots. This quantity checking prevents the malpractice of misplaced or lost the shipped items and ensures the exact quantity as it was from the base station. It is therefore clear that the successful tracking and tracing embedded within business application requires item coding for necessary identification. Usually items or products that differ in form, fit or function are tagged with a different code [30].

5.3 Available Tracking and Tracing Software

With the view to maximize profits and gain the vital competitive edge over rival companies, it is very important to capitalized business with the latest tracking and tracing technology. Good business should have a controlled and well planned approach to work. This means that good software can track and trace the business activities throughout the delivery process. The software not only maximizing efficiency in the delivery and collection process, but also allows firms to give far better customer service. It enables to inform the client of an item’s exact position, thereby offering a more accurate estimated time of arrival and able to nip a problem in the bud putting the delivery back on schedule. Most of the tracking and tracing software are purely internet based real-time system that users can access from anywhere that has an internet connection and a web browser.

The web-based technologies used in the software system enable secure remote access to the system from any location at any real-time. These technologies have sound knowledge in both key areas of transport management and warehouse management which offer optimum performance and reliability on the traffic or warehouse system. Accurate and applicable real-time tracking technologies for logistics network create common understanding about how to facilitate logistics network in the development of overall companies’ goals. The common benefits from real-time tracking technologies can be summaries as:

- identify and address the weaknesses in firms supply networks
- the ability to manage suppliers performance
- reduce total freight costs
- optimize firms inventory management
- increasing firms efficiency by planning ahead
- more power in pricing negotiations
- reduction in lead times
- reduction in back orders
There are various forms of tracking and tracing devices/technologies. Some tracking devices reporting vibrations and shocks during transportation as displayed in Figure 3. This type of device tracked the transported items through sensing the vibrations and shocks initiated from the transported items. Other forms of tracking devices use ground positioning system (GPS) for tracked the transported items. This device uses satellites to navigate the shipped items as displayed in Figure 4.

The satellite navigation system as implemented by the GPS technology offers real-time tracking information to the potential customers. Customers could interact with the shipped items by using internet technology from where they could browse their expected tracking information. Figure 5 displays a snapshot of the real-time tracking device.
Shamsuzzoha and Helo

Figure 5: Potential software user interfaces for real time project tracking.

Through implementing web-based technology, customers could even be able to use touch operated tracking device as seen in Figure 6. This type of device is able to display the shipped item by using touch screen technology. If a customer put his/her finger on the display monitor he/she would be able to track the item’s location on a real-time environment.

Figure 6: Touch operated tracking-display.

6. Methodology to Support Collaborative Logistics Tracking and Tracing Networks

Due to today’s collaborative business environment, manufacturing organizations are needed to track and trace their logistics chains in a collaborative fashion. Owing to the multi-company nature of supply networks of logistics processes, different parties of the logistics network need to liaise and cooperate in determining the requirements for tracking and tracing systems [9]. Before establishing the necessary cooperation among collaborative partners, they need to follow several consecutive steps such as unique goods identification technology to be used, coding of the tracked items, the content and way of exchanging tracking information, information architecture to be used in the tracking application and the available methods of accessing the tracking information [10, 11].

The most essential concern of the collaborative tracking system is to the span and range for collecting the tracking information. There are two forms of operations for tracking logistics service provider namely independently operated for a single company and multiple operated from where different companies are able to receive their tracking information. There needs information architecture in order to building and accessing the tracking information. Two different types information architecture is available in the tracking and tracing system [11]. In the first type, the tracking system send the tracking information to each party in the logistics network, whereas in the
Shamsuzzoha and Helo

second type the tracking information is accommodated to a central information system from where collaborative partners can receive the tracking information by manual request (e-mail, telephone, fax etc).

Another form of information tracking in a collaborative environment is used by automatically operated system where the central tracking of information is performed by Electronic Data Interchange (EDI) or XML message interface. In an automated tracking system the basic pieces of information of the track item such as name of the item, location of the item and time strap of the item is provided. This system also provides accessibility of information directly to the network partners through internet using World Wide Web. This tracking method ensures planned delivery dates and automatic follow-up of the logistics deliveries. The information architecture of the automated tracking system supports the time-schedule for the implementation option of real-time tracking technology that facilitates tracing in collaborative logistics networks in varying situations and integrates them as a part of partners’ strategic activities.

7. Conclusions

This article presents a state-of-the-art overview of the logistics tracking and tracing network. It is not only defined from definitions and specifications point of views but also from available technologies point of views too. The importance and the organizational scope of tracking and tracing are elaborated within the scope of this article. This article illustrated that tracking and tracing transcends organization borders and extends to include all elements of the logistics networks, as well as external parties of the business environment. The three research questions are discussed and analyzed in terms of needs, implementation and methods for collaborative customers’ companies logistics networks. The generic scope of information flows within logistics chains are defined in respect to IT-solution.

A structure of basic architecture for tracking and tracing network along with generic technology behind the tracking and tracing network is defined and discussed. In this content, available tracking and tracing software are presented and explained their operational activities are described briefly. All these software tools supports the real-time tracking technologies required for online tracking information across the logistics chains. In this paper, we have also presented the methodology to support the collaborative logistics tracking and tracing, where the networks partners could tracked their shipments easily and efficiency on real-time basis. These tracking messages are transmitted through automatically EDI or XML message interface to the partners’ internal receivers.

The intention of this research was to indentify the basic needs and potential technologies for tracking and tracing the shipped items. The presented approach could be taken as a reference structure for logistics tracking and the exemplary instances alongside the development structure may help to illustrate the layers and concepts of tracking and tracing projects even further. This article lacks of constructive implementation works of the tracking technologies in length however; the references provided in this paper could be an added value to the potential readers to study more detail of the tracking and tracing theme and technology behind it as a whole. Considering the implementation structure of the tracking technology, future research will continue to describe practical business cases in detail and assess the sophistication of the technology applied.

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References

Shamsuzzoha and Helo